Towards Strategies for a Carbon-neutral Swiss Chemical Industry

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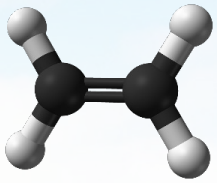
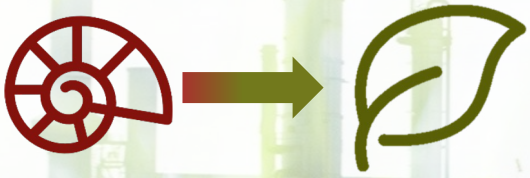
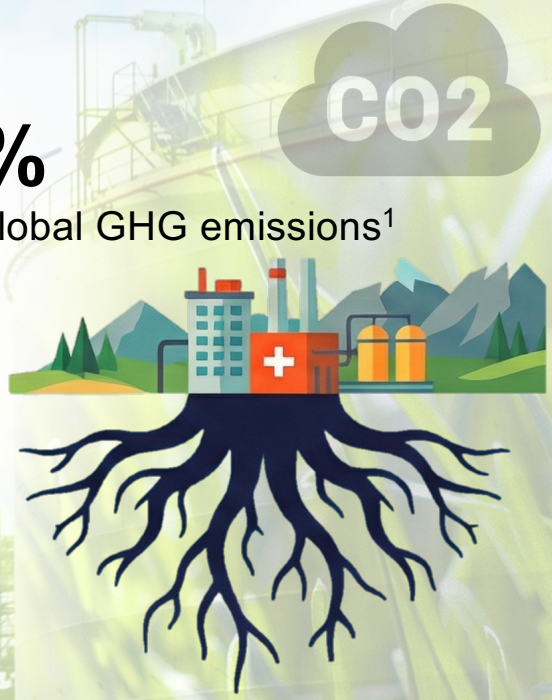
The chemical industry inherently needs carbon



Many chemicals require carbon bonds



Defossilize carbon source

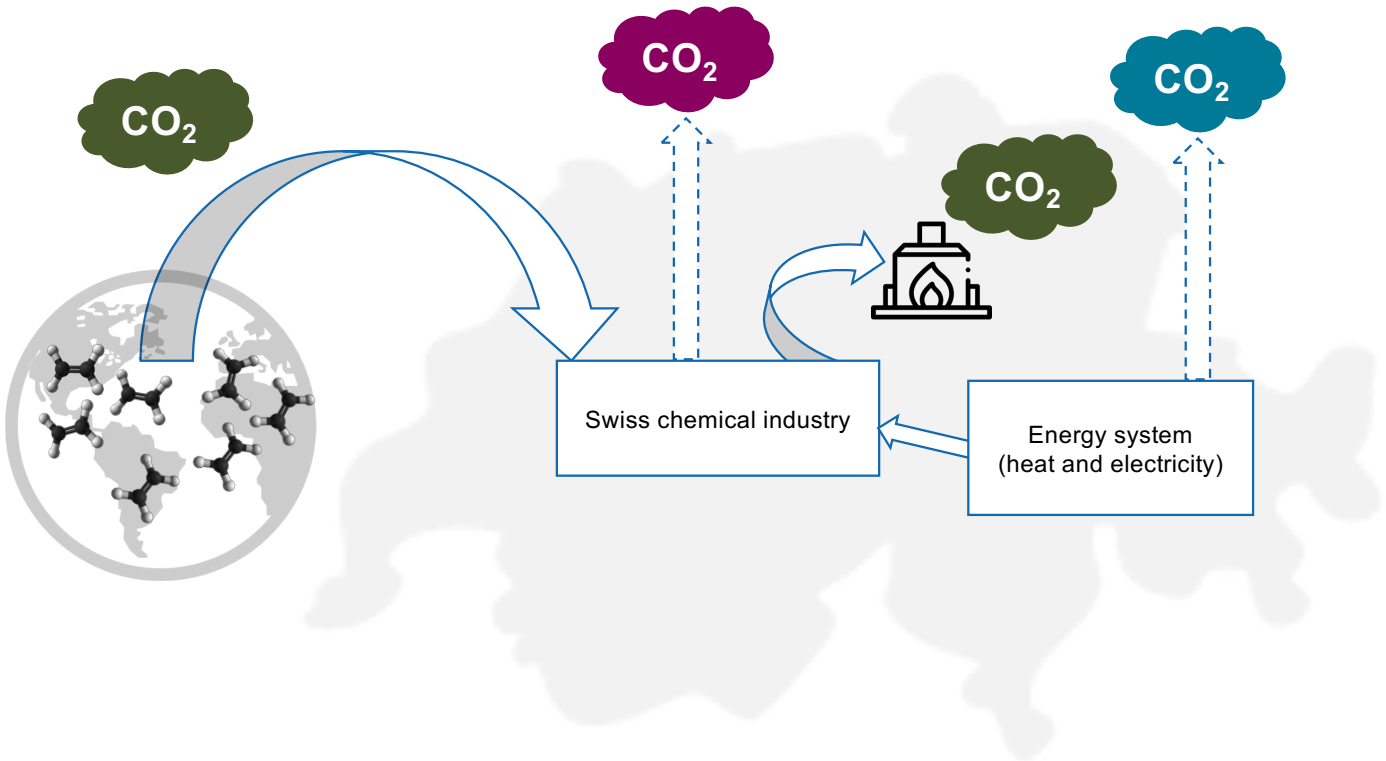


7%

of global GHG emissions[1]

1. Pistillo, A. (2022). Setting standards to decarbonise the chemical industry. Together for Sustainability (TfS), Belgium. Retrieved from https://www.iscc-system.org/wp-content/uploads/2022/12/Alessandro-Pistillo-Co-Chair-of-Work-Stream-GHG-Scope-3-Sustainability-Together-for-Sustainability-TfS-Belgium-Setting-Standards-to-Decarbonise-the-Chemical-Industry.pdf

Interlude: What are emission scopes?



Scope 1

- Direct process emissions
- From fuel combustion and leakages

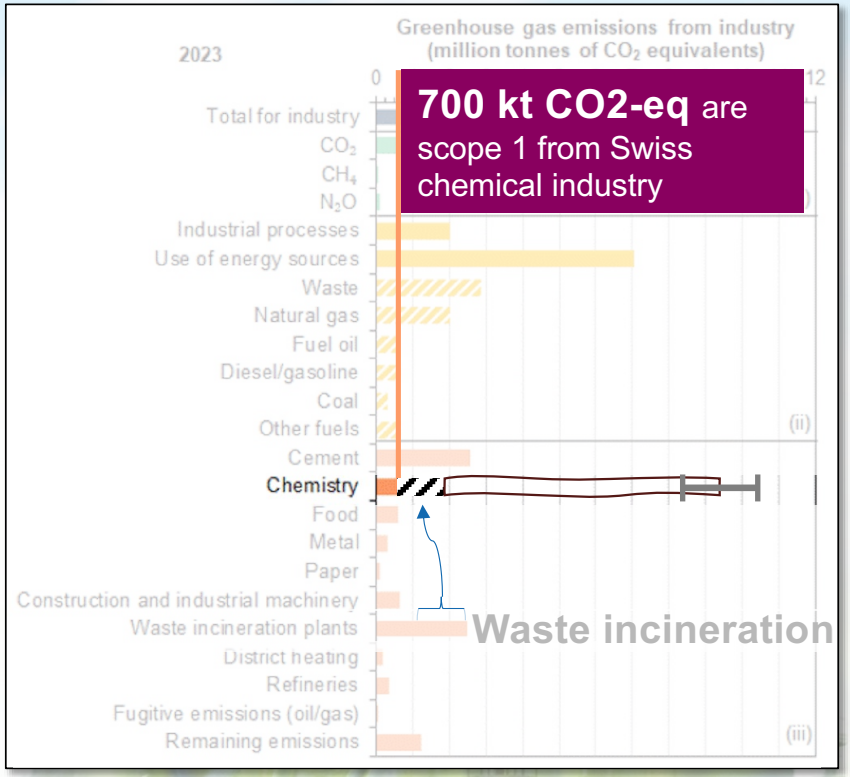
Scope 2

- Purchased utilities, e.g., electricity and heat

Scope 3

- Upstream: Emitted before production, e.g., due to feedstock imports
- Downstream: Use-phase, transportation, end-of-life treatment emissions

The Swiss chemical industry's footprint: A matter of Scope



700 kt CO2-eq are scope 1 from Swiss chemical industry

GHG inventory (FOEN) only reports Scope 1 emissions for each sector

But what other emissions is a sector responsible for?

For a comprehensive accounting, look at Scope 2 and 3 emissions

Electricity, heat, other utilities?

Waste treatment, chemical imports?

1. Federal Office for the Environment FOEN. Switzerland's greenhouse gas inventory. Switzerland's greenhouse gas inventory https://www.bafu.admin.ch/bafu/en/home/topics/climate/state/data/greenhouse-gas-inventory.html (2025).

Legal context: Defossilization of the Swiss chemical industry

Constitutional Basis

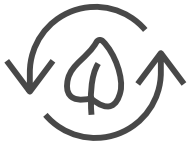
Art. 74 protects humans and the environment.
Art. 89 promotes sustainable energy use.

CO_2 Act

CO_2 levy on thermal fuels → Economic pressure to reduce fossil energy.

Climate and Innovation Act

Net-zero emissions by 2050 legally binding for all sectors.

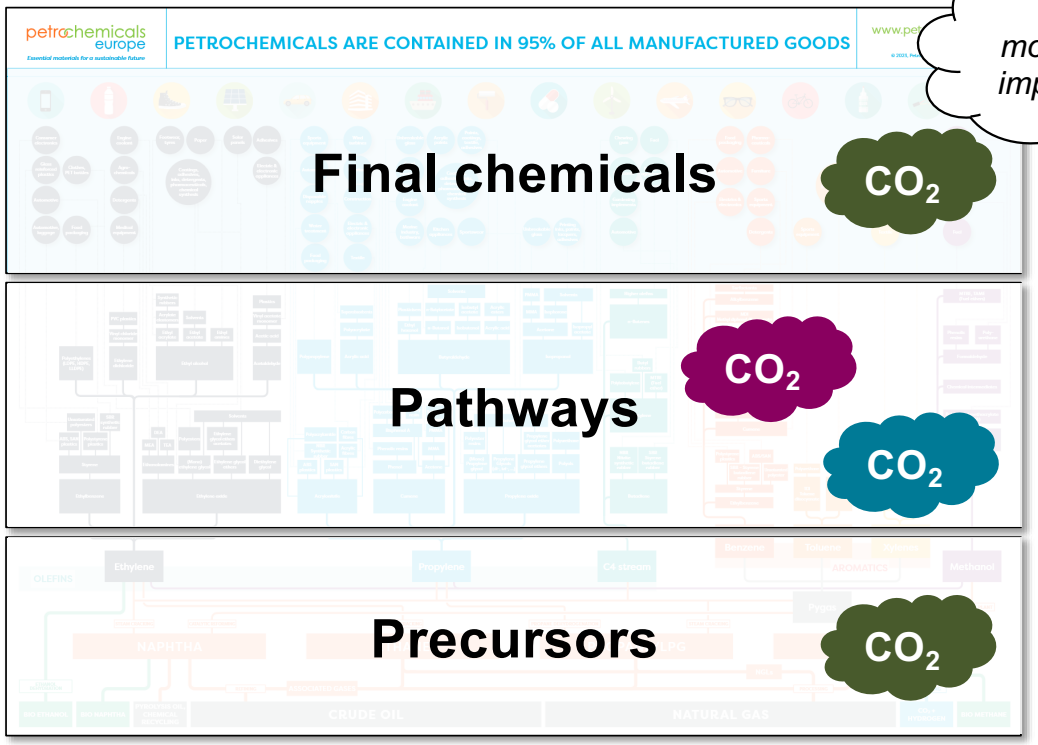


Environmental Protection Act

Recycling is prioritized over incineration

CIA (only concrete, legally-binding act) only focuses on Scope 1 and 2 emissions

Modeling the Swiss chemical industry: A Research Gap



Where is most room for improvement?

We want to make the Swiss chemical industry net-zero!

Scope 1
Scope 2
Scope 3

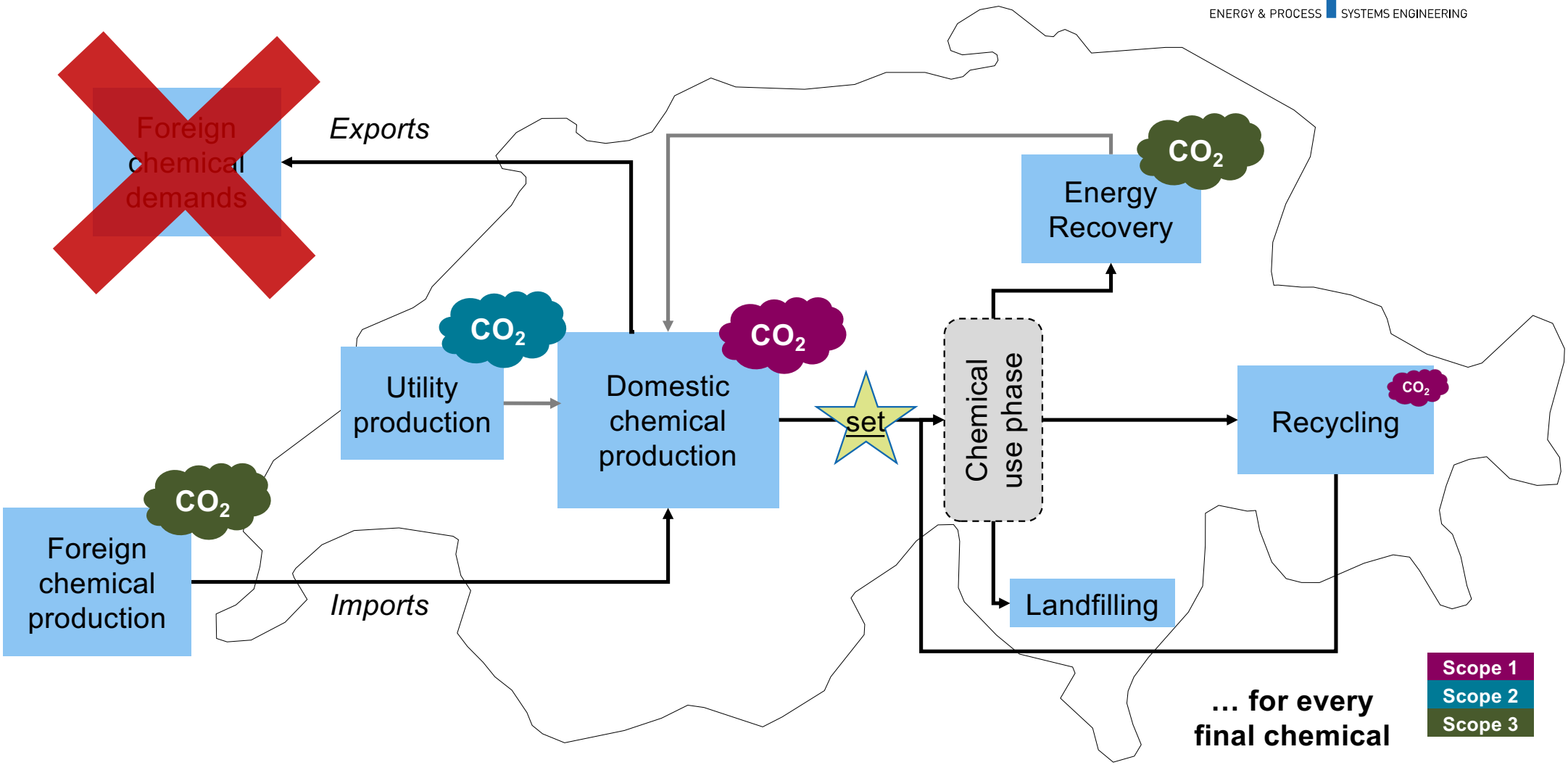
→ How large is this bar really?

?

Where do emissions occur along the chemical supply chain currently?

Which processes and products dominate total emissions?

Model concept for the Swiss chemical industry



SecMOD can help us map the status quo of the Swiss chemical industry

Our tool:

Inputs

- Production volumes for Swiss chemical industry excl. pharma [1]
- Process data [2]
- Carbon footprints [3]

SecMOD [4]

- Mass and energy balances
- Integrated LCA: Emission factors linked to technologies

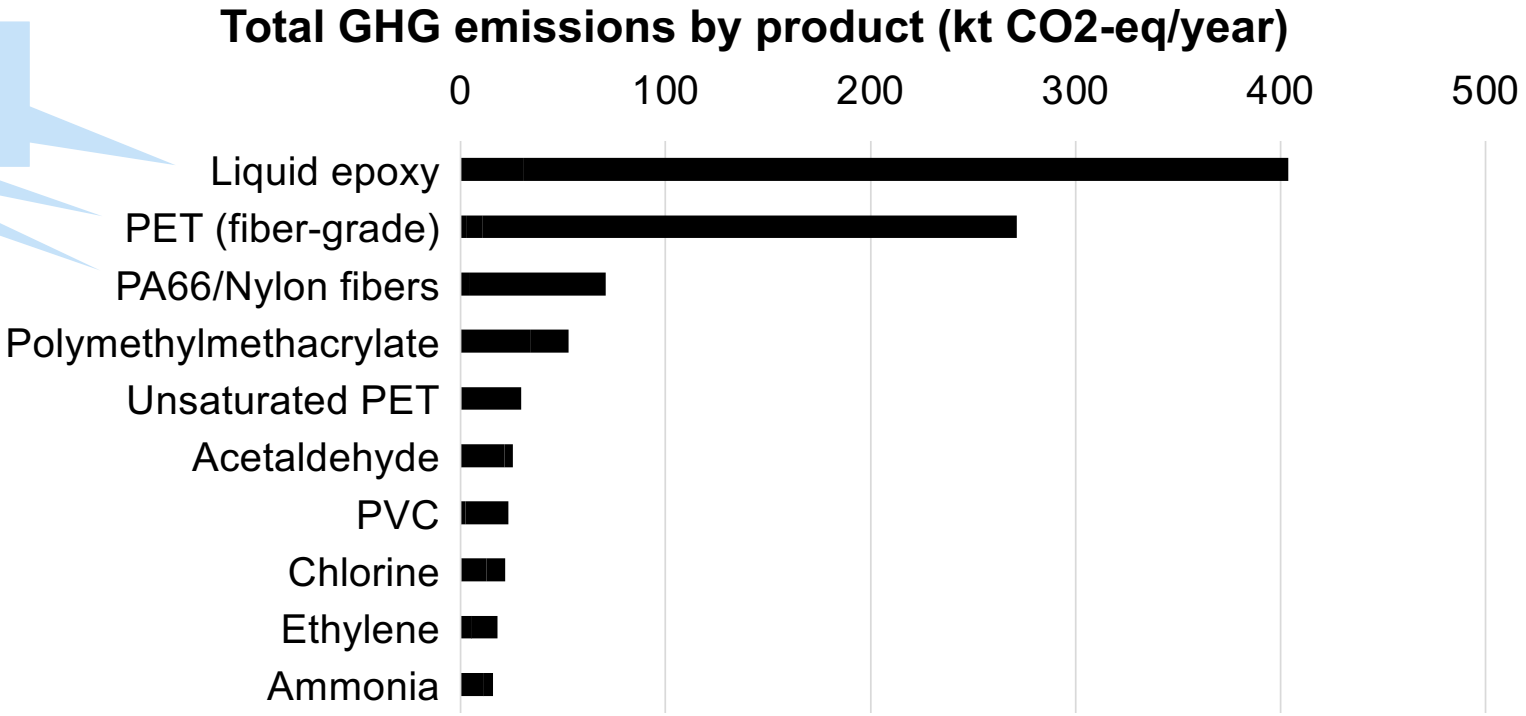
Outputs

- Mass flows within Swiss chemical industry
- GHG emissions by Scopes

1. ICIS. Supply and Demand Database. https://icis.com/explore/services/supply-and-demand-database (2025).
2. IHS Markit. Process Economics Program (PEP) Yearbook. https://spglobal.com/energy/en/products-solutions/chemicals/chemical-process-economics-program-pep (2018).
3. ecoinvent Association. ecoinvent version 3.11. https://ecoinvent.org/ecoinvent-v3-11 (2024).
4. Reinert, C. et al. SecMOD: An Open-Source Modular Framework Combining Multi-Sector System Optimization and Life-Cycle Assessment. Front. Energy Res. 10, 884525 (2022).

Just three chemicals are responsible for 80% of the total GHG emissions from the Swiss chemical production

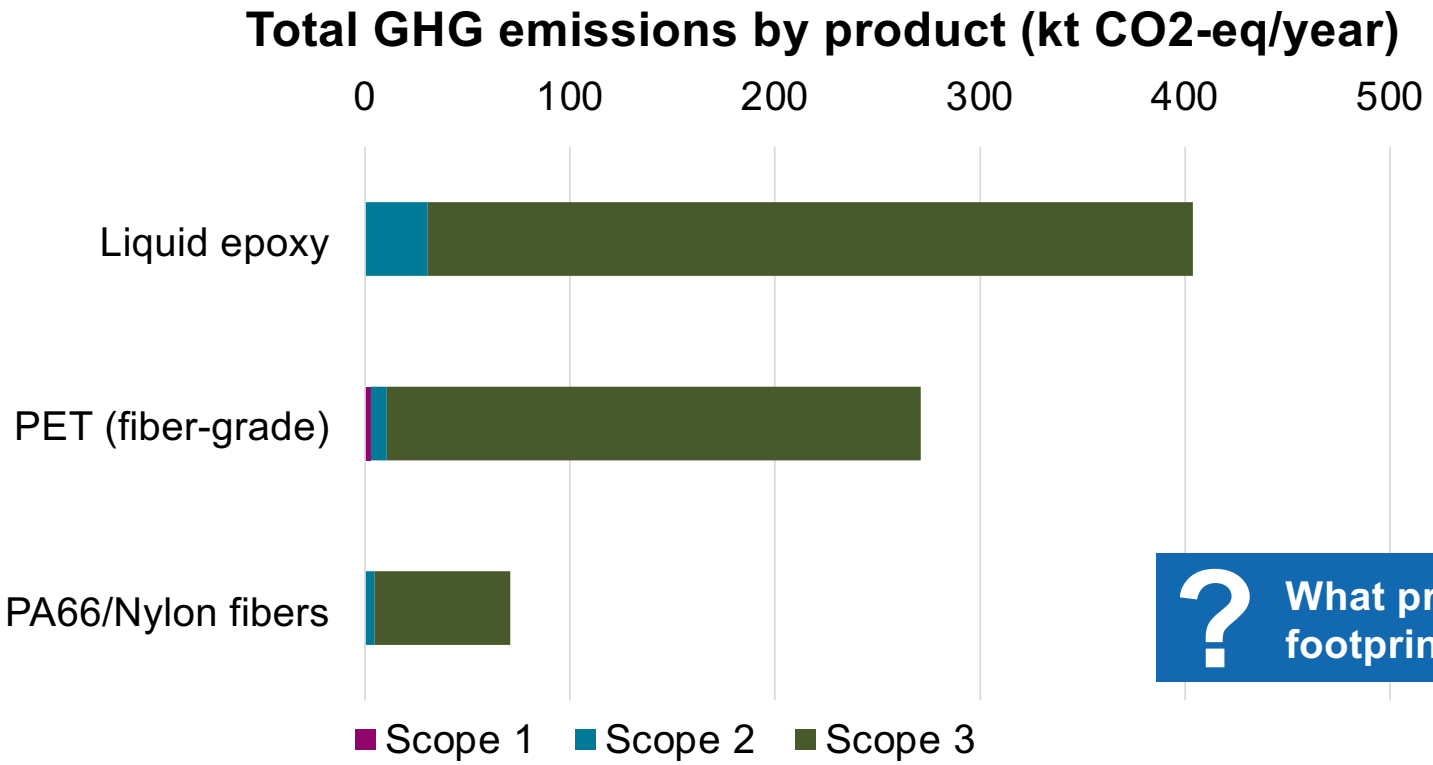
80%
of the total GHG emissions



Reducing the impact of three chemicals could already be a major step towards climate-neutrality

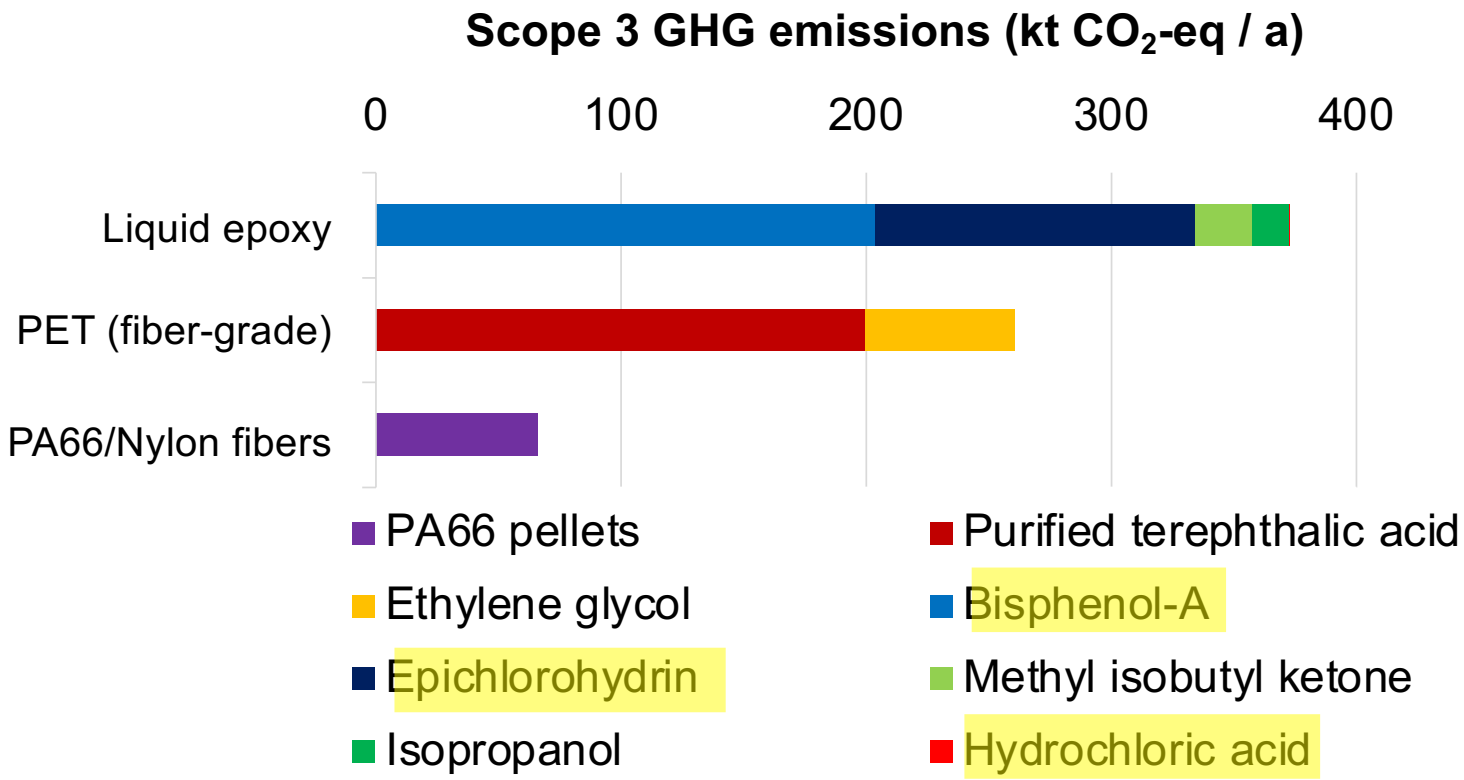
? But what are the largest contributors to their carbon intensity?

More than 90% of the GHG emissions from the most emitting chemicals are Scope 3 emissions



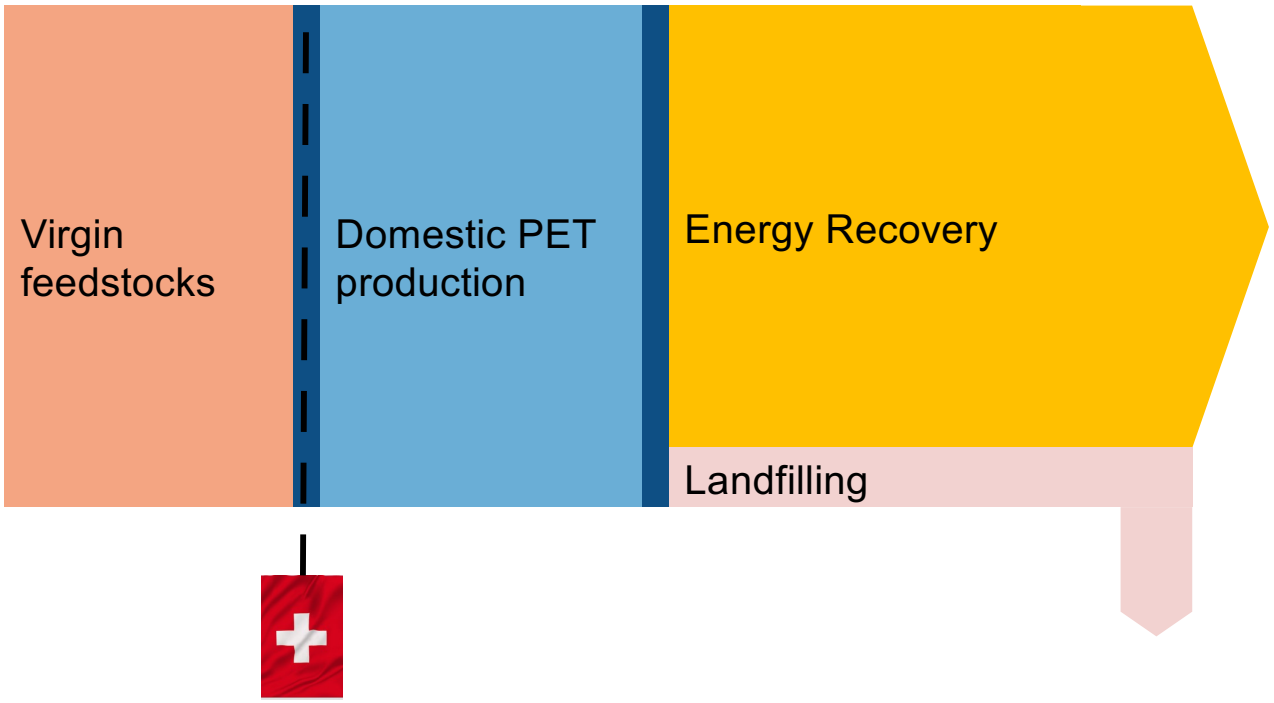
? What precursors cause the large footprint?

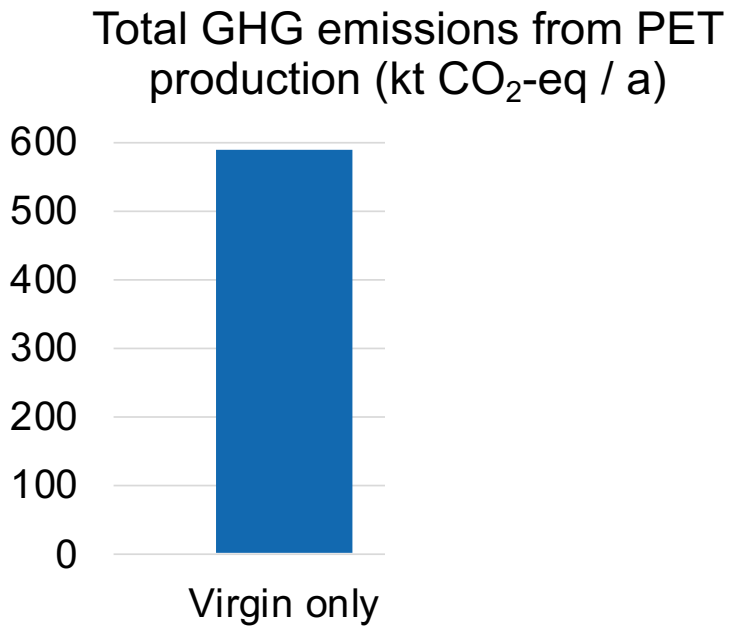
Only a few imported precursors drive the majority of emissions



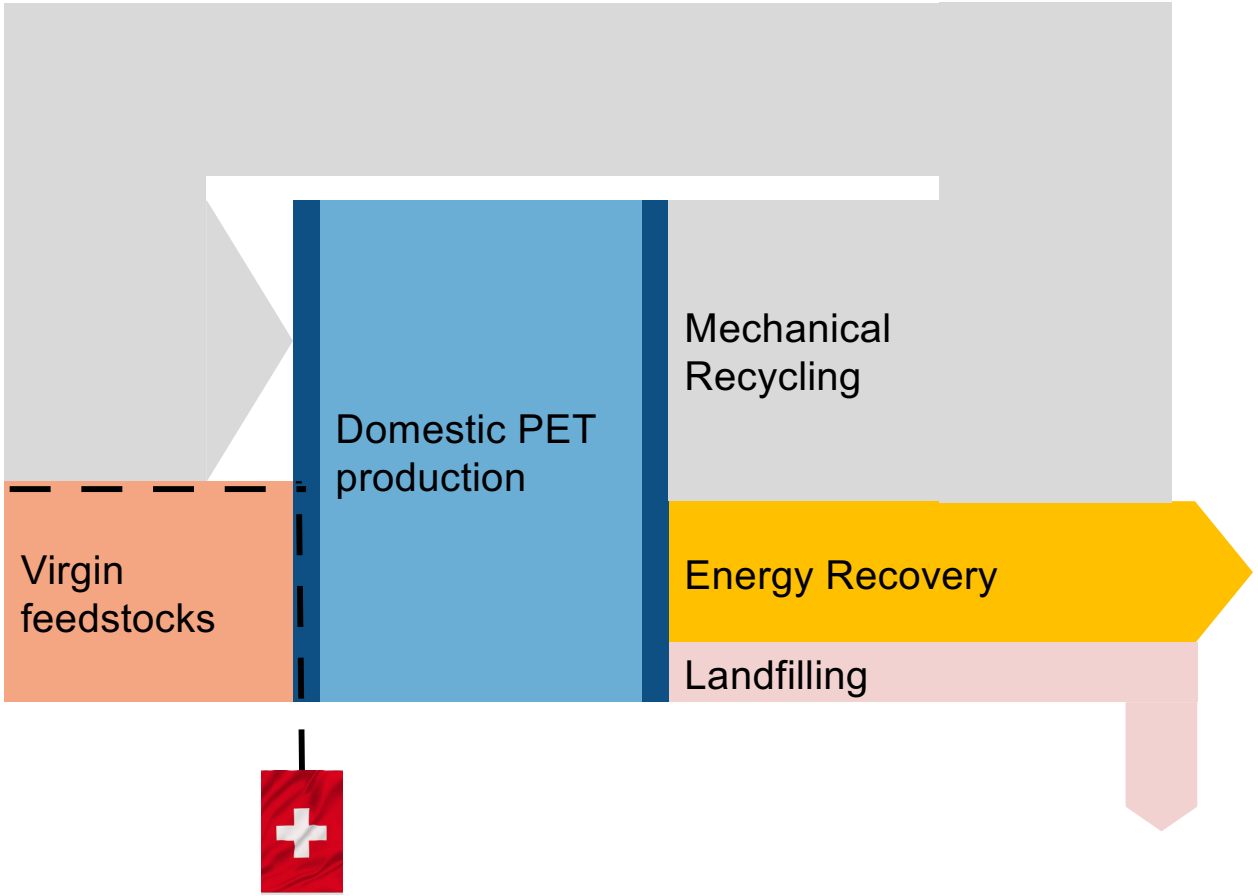
67% of Scope 3 emissions are due to **three precursors.**

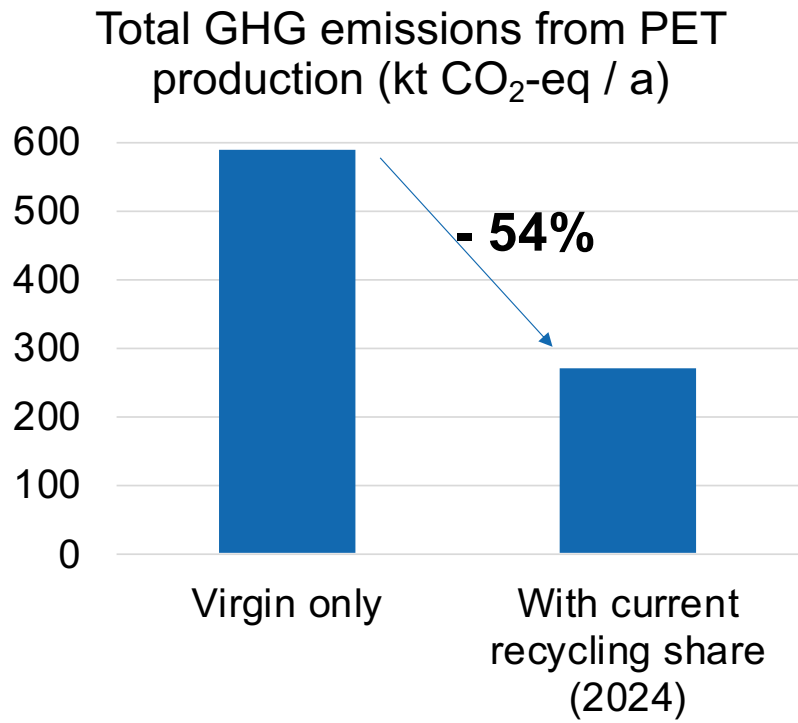
Comparison: Virgin PET vs. with the current Swiss recycling rate (1/2)





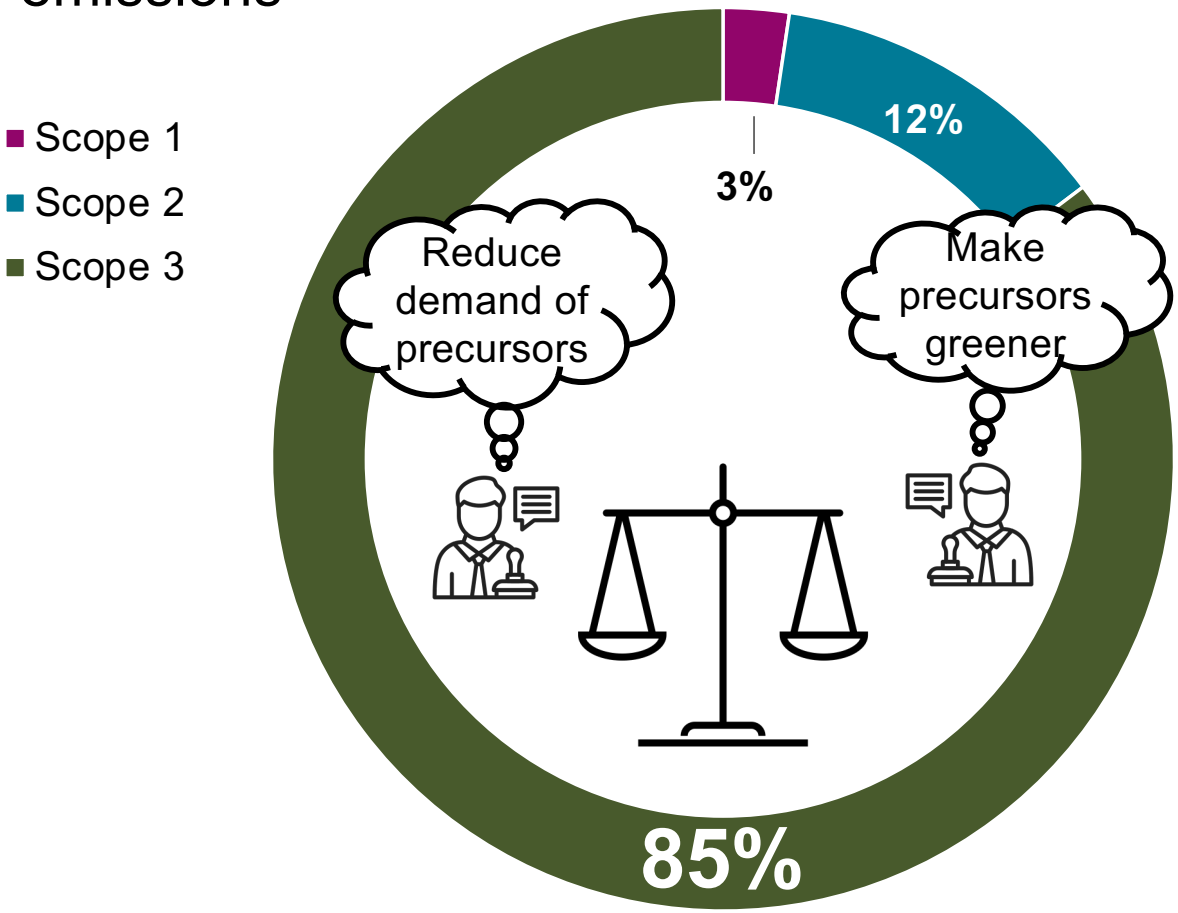
Comparison: Virgin PET vs. with the current Swiss recycling rate (2/2)





Recycling helps reduce the demand of GHG-intensive precursors

The Swiss chemical industry imports 85% of its GHG emissions



Breakdown of GHG emissions by scopes

Reducing the footprint of chemicals = Reduce Scope 3 emissions

Recycling as one way to reduce precursor demand

Outcomes and limitations of our study

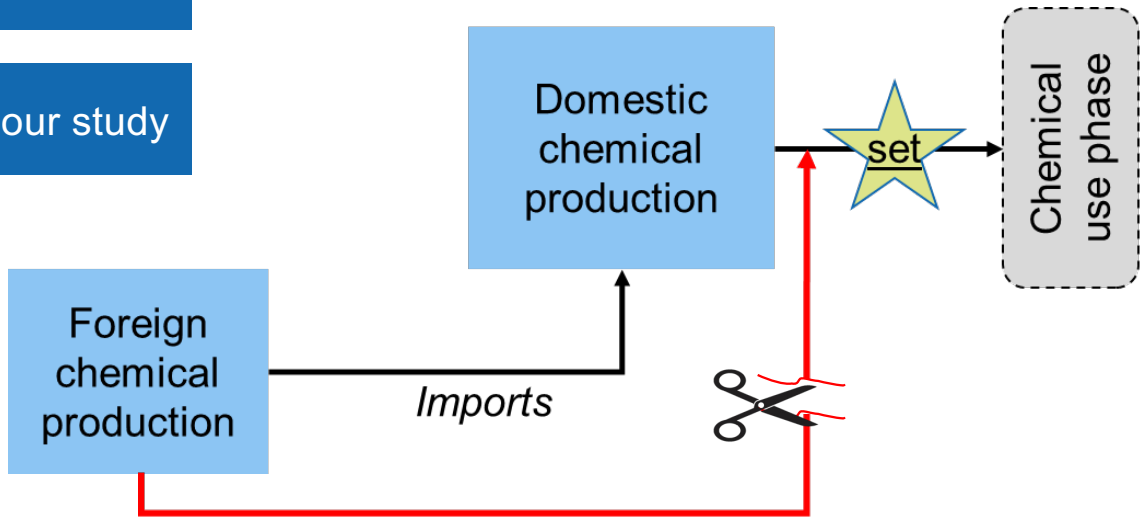
Initial question:

How large is the true bar?

We know Scope 1, 2, and 3 emissions for current domestic production

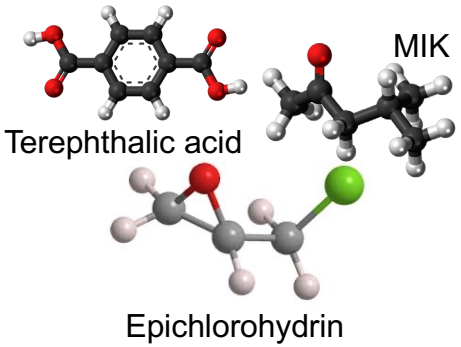
? Import of final chemicals still not taken into account

? Pharmaceutical industry is excluded from our study

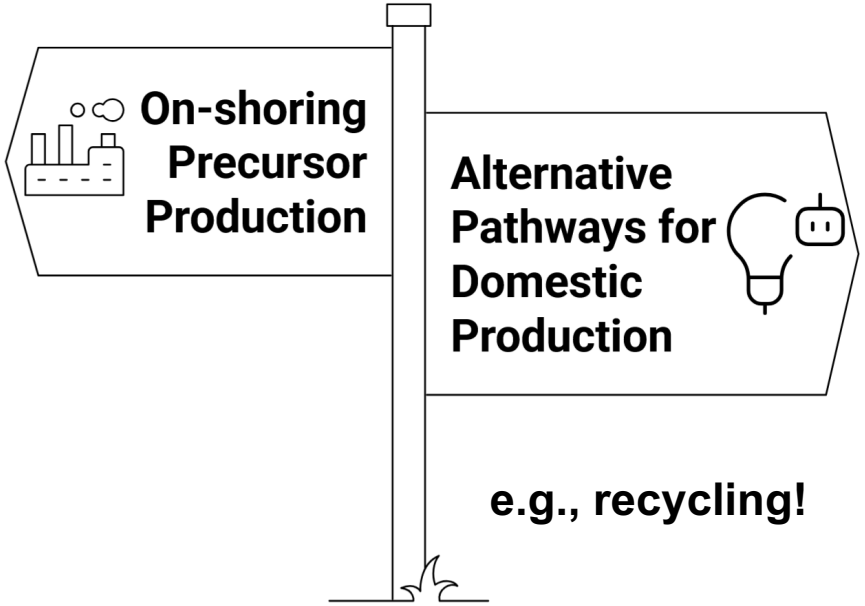


Summary and Outlook

85% of GHG emissions are imported



Import of three precursors responsible for 67% of scope 3 emissions (57% of total)



Thank you for your attention!

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